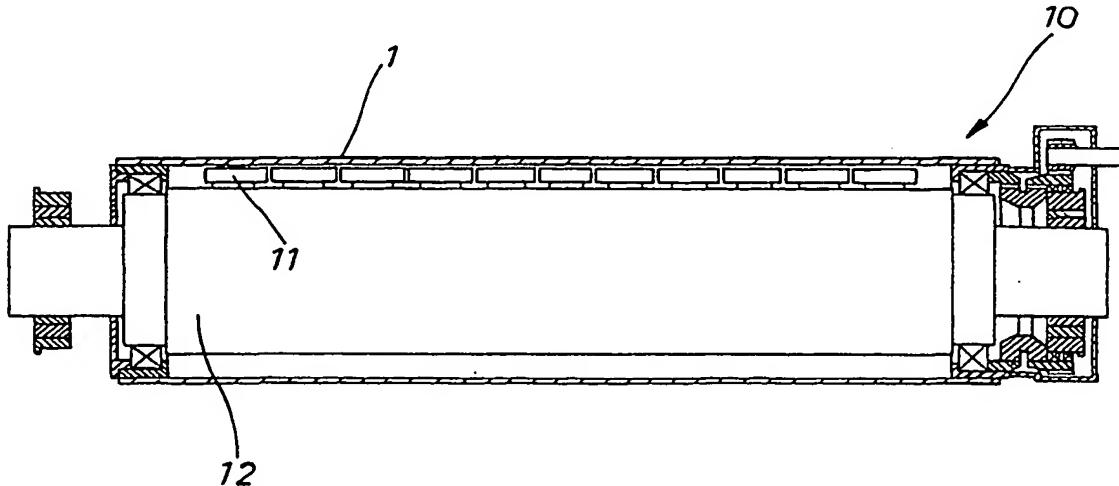




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>D21G 1/02 // C22C 1/09, D21F 1/08</b>	A1	(11) International Publication Number: <b>WO 99/63154</b> (43) International Publication Date: 9 December 1999 (09.12.99)
(21) International Application Number: <b>PCT/FI99/00439</b>		(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
(22) International Filing Date: 21 May 1999 (21.05.99)		
(30) Priority Data: 981240 2 June 1998 (02.06.98) FI		
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(54) Title: SHELL FOR A NIP ROLL



## (57) Abstract

The invention relates to a composite shell (1) for a nip roll in a paper/roll or finishing machine and to a method for manufacturing a composite shell. The shell (1) is provided with means (2, 4), extending at least partially in its depthwise direction and existing within the shell material and providing a depthwise reinforcement for the shell. The means are constituted by partial fiber lengths (4) and/or short fibers (2), extending at least partially depthwise of the shell.

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## Shell for a nip roll

The present invention relates to a composite shell for a nip roll in a paper/board or finishing or converting machine, comprising a plurality of fiber layers extending lengthwise and/or circumferentially of the shell. The invention relates also to a method for manufacturing a composite shell for a nip roll in a paper/board or finishing or converting machine, comprising a polymeric matrix material and a plurality of fiber layers extending lengthwise and/or circumferentially of the shell. The invention relates further to a method for manufacturing a composite shell (1) for a nip roll in a paper/board or finishing or converting machine, comprising reinforcing fibers and a matrix material of ceramics.

The term composite refers to a structure which comprises reinforcing fibers, e.g. carbon, boric or glass fibers or mixtures thereof, and a matrix material which can be polymeric, ceramic or metallic. The ceramic material comprises various oxides and carbides, such as e.g. Al-, B-, Cr-, Ti-, Si-, Sn-, W-, Zn-, Zr-oxides and -carbides and mixtures thereof, as well as various nitrides, such as e.g. BN and  $\text{Si}_3\text{N}_4$ .

20

A composite shell for a nip roll, comprising a plurality of divergent fiber layers, is prior known in the field, e.g. from the patent publication FI 100264. Regarding the prior art composite shells for nip rolls, the strength thereof has been attempted to be enhanced by different orientations of fibers constituting the fiber layers in the axial direction of the roll or in divergent directions along the circumference. One problem in conventional composite shells in connection with nip rolls is the exposure thereof to local bending stresses, resulting in problems in terms of strength. Such a local bending stress may lead e.g. to the peeling of fiber layers which constitute the composite shell. Thus, an object of the present invention is 25 to provide such a nip roll shell which has an increased strength in the depthwise direction in addition to an axial and circumferential strength. In order to achieve this object, a nip roll composite shell of the invention is characterized in that the shell is provided with means, extending at least partially in its depthwise direction

and existing within the shell material and providing a depthwise reinforcement for the shell.

A method of the invention for manufacturing a composite shell for a nip roll,

5 comprising a polymeric matrix material and a plurality of fiber layers extending essentially lengthwise and/or circumferentially of the shell, is characterized in that the fibers used in the method for building the fiber layers are dipped in a resin admixed with short fibers, which in a finished shell provide the shell with an increased depthwise strength. A method according to another aspect of the

10 invention for manufacturing a composite shell for a nip roll in a paper/board or finishing machine, comprising reinforcing fibers and a substantially integral matrix material of ceramics, is in turn characterized in that the method involves first the manufacturing of a three-dimensional fiber structure affording an added depthwise strength and the matrix material is introduced by thermal processes,

15 such as a thermal injection, as a plasma vapour into the fiber structure for producing an integral matrix.

The invention will now be described in more detail with reference to the accompanying drawings, in which:

20

fig. 1 shows a nip roll in a schematic sectional view, and

figs. 2-5 show a few exemplary embodiments for a nip roll shell of the invention in cross-sectionally taken schematic partial views.

25

Fig. 1 depicts one embodiment for a nip roll 10, wherein a stationary central axle 12 is provided with loading shoes 11 loading a shell 1 in the nip direction. The shell is made of a composite material.

30 Fig. 2 shows in a cross-sectionally taken enlarged partial view a composite shell 1 constructed in a normal fashion from continuous-strand reinforcing fibers 3, e.g. carbon fibers, and a polymeric matrix material, in the manufacture of which the resin used for bonding the reinforcing fibers 3 is admixed with short fibers 2, at

least some of which extend, as far as a finished shell is concerned, depthwise of the shell providing an added depthwise strength for the shell wall. In the manufacture of a composite shell as shown in fig. 2, the fibers 3 used for fabricating the fiber layers are dipped in a resin, e.g. epoxy resin, which is

5 admixed with short fibers, e.g. carbon fibers, whereby, after the resin is set, said short fibers provide an increased depthwise strength for the finished shell.

Fig. 3 shows a cross-sectionally taken enlarged partial view of a nip roll composite shell 1, including lengthwise fibers 5, transverse fibers 3, and

10 rectangularly waving fibers 4, bonding the discussed lengthwise and transverse fibers and building a three-dimensional fiber structure and extending at least principally in the depthwise direction of the wall of the shell 1 (an arrow S).

Figs. 4-5 show a cross-sectionally taken enlarged partial view of a nip roll composite shell 1, including lengthwise fibers 5 and fibers 4, constituting together with the discussed lengthwise fibers a three-dimensional fiber structure and extending in a wavelike or serrated pattern and being placed at least partially in the depthwise direction of the shell 1. The wavelike or serrated fibers 4 provide a finished shell with a strength depthwise of the shell after the setting of a resin or

20 a ceramic material used for bonding the fibers. When using a ceramic matrix, the reinforced fiber structure is first formed e.g. on top of a mould and the matrix is introduced by thermal processes, such as a thermal injection, as a plasma vapour into the fiber structure for producing an integral matrix and resulting in a so-called ceramic composite.

25 In this application, the term "at least partially depthwise of the shell" refers to the direction which extends through the wall of a shell in the radial direction of a roll, the arrow S in figs. 3-5, or diagonally relative thereto.

30 The various embodiments for a composite structure described above in reference to figs. 2-5 are also conceivable to be implemented as various combinations thereof, wherein the depthwise dimension of a shell comprises layers of various composite structures. One such combination can be for example a base layer

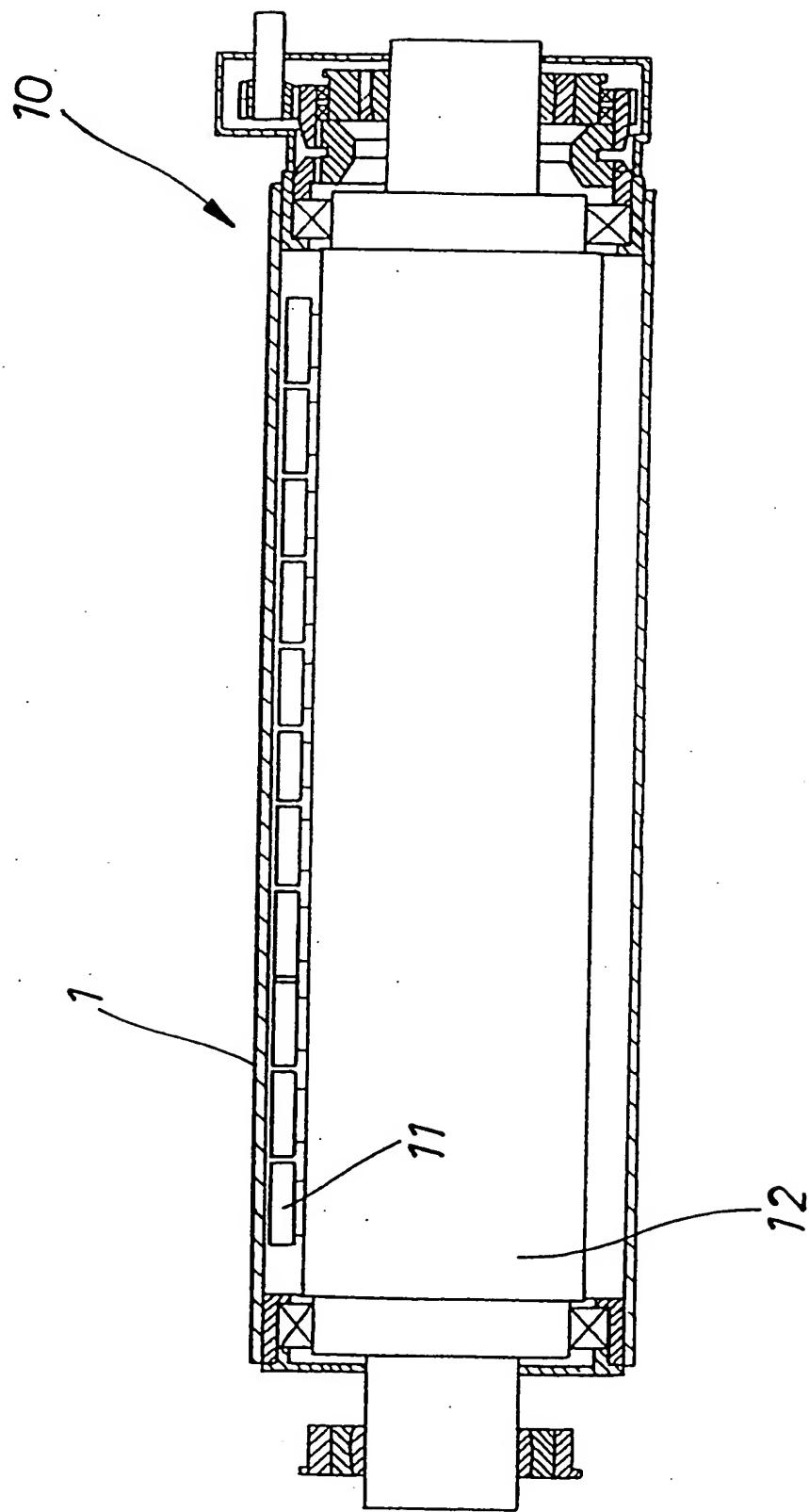
wound from continuous-strand reinforcing fibers, having its inner and/or outer surface provided with a three-dimensional fiber structure. In addition to the fiber structure, it is also possible to employ various matrix materials in various depthwise locations of a shell, whereby, for example, the layer constituting the

5 inner surface can be provided with a polymeric matrix material and the layer constituting the outer surface with a ceramic material.

Claims

1. A composite shell (1) for a nip roll in a paper/board or finishing or converting machine, comprising a plurality of fiber layers (3) extending lengthwise and/or circumferentially of the shell, characterized in that the shell (1) is provided with means (2, 4), extending at least partially in its depthwise direction and existing within the shell material and providing a depthwise reinforcement for the shell.  
5
2. A composite shell as set forth in claim 1, characterized in that said means are constituted by partial fiber lengths (4) and/or short fibers (2), extending at least partially depthwise of the shell.  
10
3. A composite shell as set forth in claim 2, characterized in that the fibers of a composite structure provide a three-dimensional fiber structure at over a part of the shell depth, and that said partial lengths are constituted by the fibers (4), included in said fiber structure and extending at least partially depthwise of the shell.  
15
4. A composite shell as set forth in claim 2, characterized in that said short fibers are admixed in a resin used for bonding the long fibers which constitute the fiber layers.  
20
5. A composite shell as set forth in any of claims 1-4, characterized in that the matrix material bonding the fibers of a composite structure is constituted in the depthwise direction of the shell by at least two layers bonded integrally to each other and consisting of materials different from each other.  
25
6. A method for manufacturing a composite shell (1) for a nip roll in a paper/board or finishing or converting machine, comprising a polymeric matrix material and a plurality of fiber layers (3) extending lengthwise and/or circumferentially of the shell, characterized in that the fibers (3) used in the method for building the fiber layers are dipped in a resin admixed with short fibers, which in a finished shell provide the shell with an increased depthwise strength.  
30

7. A method for manufacturing a composite shell (1) for a nip roll in a paper/board or finishing machine, comprising reinforcing fibers and an essentially integral matrix material of ceramics or a metal, characterized in that the method involves first the manufacturing of a three-dimensional reinforced fiber structure and the
- 5 matrix material is introduced by thermal processes, such as a thermal injection, as a plasma vapour into the fiber structure for producing an integral matrix.



*Fig. 1*

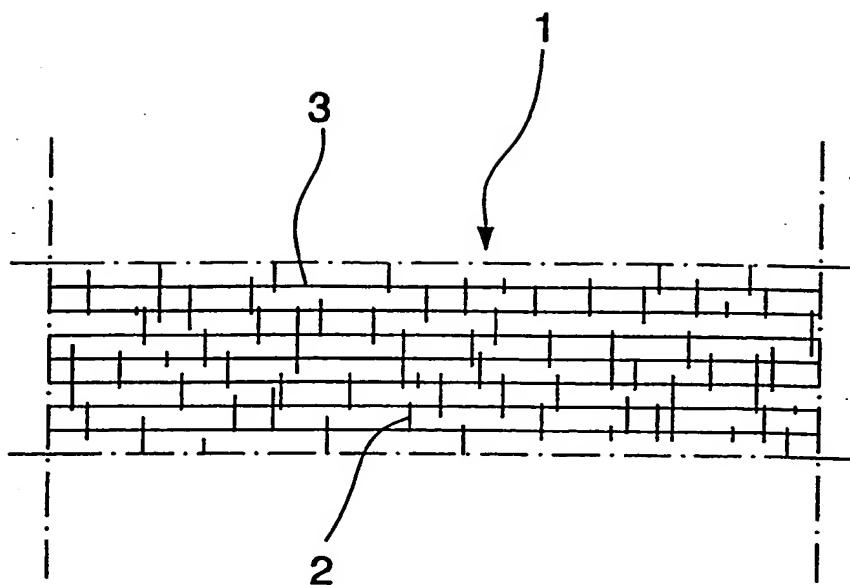


Fig.2

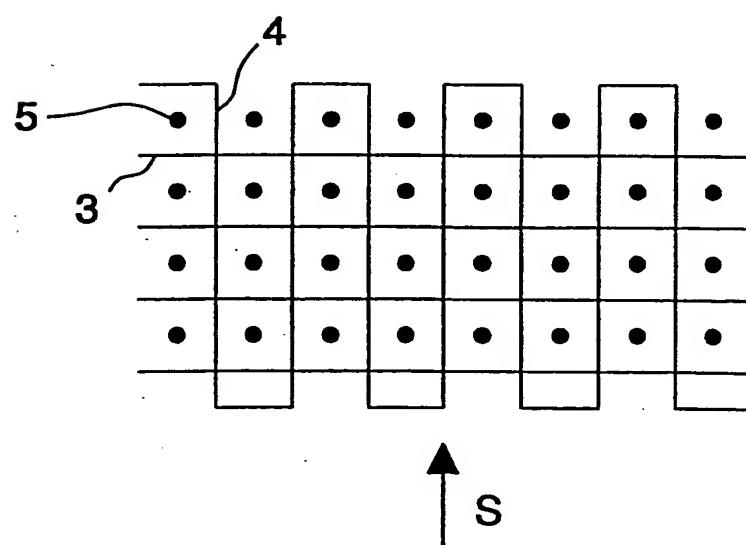


Fig.3

3/3

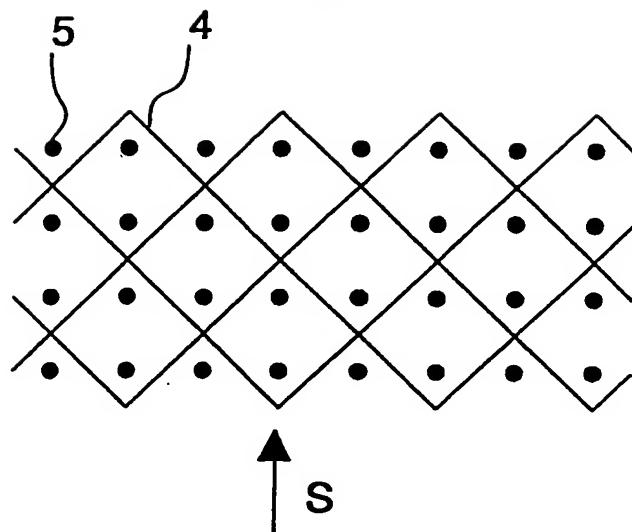


Fig.4

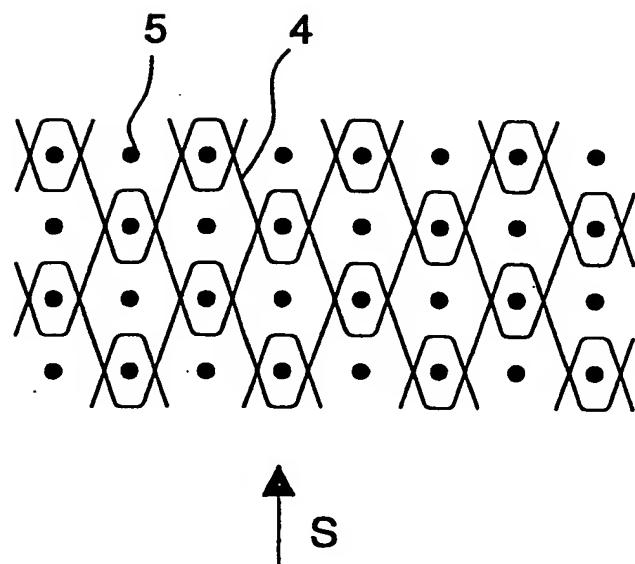


Fig.5

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00439

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC6: D21G 1/02 // C22C 001/09, D21F 001/08**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC6: D21G, D21F, C22C, C04B**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**EPODOC, WPI, PAJ, TXTE**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9409208 A1 (BELOIT TECHNOLOGIES, INC.), 28 April 1994 (28.04.94), page 5, line 6 - page 6, line 21, figures 3,4, abstract	1-5
Y	--	1-5,6
Y	US 3788935 A (J.J.SHYNE ET AL), 29 January 1974 (29.01.74), column 1, line 28 - line 72; column 2, line 40 - line 50; column 3, line 7 - line 47, column 4, line 3 - line 9, figures 1,2, examples	1-5
Y	--	6
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	--	

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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## INTERNATIONAL SEARCH REPORT

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5188776 A (HORST WITZKE ET AL), 23 February 1993 (23.02.93), column 2, line 14 - line 44, claims 9-10, abstract --	7
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A	US 5153057 A (WILLIAM J. CORBETT ET AL), 6 October 1992 (06.10.92), column 1, line 46 - line 59; column 4, line 17 - line 20 --	7

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00439

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0433507 A1 (EXXON RESEARCH AND ENGINEERING COMPANY), 26 June 1991 (26.06.91), column 5, line 25 - line 51 -- -----	7

**INTERNATIONAL SEARCH REPORT**International application No.  
**FI99/00439****Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

**See extra sheet.**

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

**INTERNATIONAL SEARCH REPORT**

International application No.  
FI99/00439

The application contains two independent inventions, namely:

Invention 1, claims 1-6.

A composite shell for a nip roll in a paper making machine. The shell comprises a plurality of fiber layers and additional fibers extending in the depthwise direction in order to increase the mechanical strength of the shell (claim 1-5). Claim 6 is directed to a method for manufacturing the composite shell wherein the fiber layers are dipped in a resin (the matrix) admixed with short fibers, which in a finished shell provide the shell with an increased depthwise strength.

Invention 2, claim 7.

Another method for manufacturing a composite shell wherein initially a three-dimensional fiber structure is formed and thereafter a matrix metal or ceramic material is introduced by a thermal process, such as thermal injection, as a plasma vapour into the fiber structure for producing an integral matrix.

These inventions are not so linked as to form a single general inventive concept. There is no relationship among these two inventions involving a corresponding special technical feature.

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.	
PCT/FI 99/00439	

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.

PCT/FI 99/00439

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